Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY
MNRAS **435,** 1749–1757 (2013) doi:10.1093/mnras/stt1413
Advance Access publication 2013 August 29

Theoretical Stark broadening parameters for spectral lines arising from the $2p^5ns$, $2p^5np$ and $2p^5nd$ electronic configurations of Mg III

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Accepted 2013 July 29. Received 2013 July 25; in original form 2013 July 5

ABSTRACT

In the present work we report theoretical Stark widths and shifts calculated using the Griem semi-empirical approach, corresponding to 237 spectral lines of Mg III. Data are presented for an electron density of 10^{17} cm^{-3} and temperatures $T = 0.5$–10.0 (10^4 K). The matrix elements used in these calculations have been determined from 23 configurations of Mg III: $2s^22p^6$, $2s^22p^53p$, $2s^22p^54p$, $2s^22p^54f$ and $2s^22p^55f$ for even parity and $2s^22p^5ns$ ($n = 3$–6), $2s^22p^5nd$ ($n = 3$–9), $2s^22p^55g$ and $2s2p^6np$ ($n = 3$–8) for odd parity. For the intermediate coupling (IC) calculations, we use the standard method of least-squares fitting from experimental energy levels by means of the Cowan computer code. Also, in order to test the matrix elements used in our calculations, we present calculated values of 70 transition probabilities of Mg III spectral lines and 14 calculated values of radiative lifetimes of Mg III levels. There is good agreement between our calculations and experimental radiative lifetimes. Spectral lines of Mg III are relevant in astrophysics and also play an important role in the spectral analysis of laboratory plasma. Theoretical trends of the Stark broadening parameter versus the temperature for relevant lines are presented. No values of Stark parameters can be found in the bibliography.

Key words: atomic data – atomic processes.

1 INTRODUCTION

Stark broadening parameters for ionized elements are very relevant in astrophysics. Stark width data and transition probabilities can be used in the analysis of stellar abundances. It is well-known that magnesium is an important element for studying the history of nucleosynthesis in the Universe (Mashonkina 2013). Lines of Mg III have been detected in solar spectra and have been used for application to high spectral resolution measurements of astrophysical plasmas (Doschek & Cowan 1984; Larsen et al. 2011). In addition, magnesium is one of the most abundant elements on Earth, with multiple applications (Singh & Harimkar 2012). Magnesium is also present as an impurity in many industrial interest alloys, making it a good candidate for diagnosis of the properties of laser-produced plasmas (LSP) from these alloys. The LSP technique has recently begun to be used in the study of biodegradable implants made with Mg–Ca alloys, generating an interest in knowledge of the behaviour of the atomic parameters of the species magnesium (Sealy & Guo 2010).

There are in the literature several experimental and theoretical works devoted to the Stark broadening parameters of Mg I and Mg II. Recently, Cvejić et al. (2013) presented an experimental study of Stark broadening of three Mg I lines and one Mg II line. There are also several works on highly ionized magnesium (Mg X and Mg XI). However, no experimental works on Stark broadening of Mg III exist and the few existing calculations (Popović & Dimitrijević 1996) do not cover the relevant vacuum ultraviolet region. As already indicated, Mg III appears to be a good candidate for diagnosis in future LSP experiments. The aim of the present work is to solve the lack of values for the Stark broadening parameters of Mg III.

Mg III is a member of the neon-like sequence. An exhaustive compilation of experimental wavelengths and energy levels of Mg III was carried out by (Martin & Zalubas 1980) and (Kaufman & Martin 1991). In the manner of Moore (1958), these authors use the most appropriate notation to describe the energy levels in each case: *jl* coupling or *LS* coupling. In this article, we have maintained this form of notation.

For the transition probabilities and oscillator strengths we could only find theoretical values in the literature. The most recent are those of Hibbert, Le Dourneuf & Mohan (1993), Das (1996), Verner, Verner & Ferland (1996), Savukov (2003) and Froese Fischer & Tachiev (2004). The latter were compiled by Kelleher & Podobedova (2008).

With regard to the lifetimes, Andersen et al. (1970) presented experimental radiative lifetimes of eight levels of the $2p^53p$ configuration of Mg III. These lifetimes were obtained using the beam-foil excitation technique. Andersen, Petrakiev Petkov & Sørensen (1975) revised six of these values and provided new measures eliminating the cascade contribution. Five levels of the $2p^54p$ and $2p^53s$

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Published by Oxford University Press on behalf of the Royal Astronomical Society

configurations were obtained from the investigation of beam-foil spectra of Mg III using a heavy ion accelerator by Lundin et al. (1973). Later, Buchet, Buchet-Poulizac & Ceyzeriat (1980) and Träbert (1996) made new measures of the level lifetimes of the $2p^5 3s$ configuration. Also, in the bibliography the theoretical values of Bureeva & Safronova (1979) are given.

Popović and Dimitrijević (1996) present calculated values of Stark parameters for 3s–3p transitions of Mg III. In this article, the authors present only widths and shifts for three lines and three multiplets.

In this work we have calculated semi-empirical values of the Stark broadening parameters for 237 lines of Mg III, in order to help remedy the lack of data on Stark broadening parameters. For these calculations we work with the well-known Griem's (1968) semi-classical approximation, by using the matrix elements of all known experimental transitions calculated in the relativistic Hartree–Fock (HFR) framework by means of Cowan (1981) computer code. Additionally, these matrix elements have been used to calculate the transition probabilities and lifetimes for the spectral lines and energy levels considered.

In this article, we present only some transition probabilities and lifetimes, those for which there are experimental values in the literature with which we could test the goodness of our calculations. Stark widths and shift parameters for spectral lines arising from the $2p^5ns$, $2p^5np$ and $2p^5nd$ electronic configurations of Mg III are presented for an electron density of $10^{17}\,\mathrm{cm}^{-3}$ and temperatures $T = 0.5$–5.0 (10^4 K). In order to display the theoretical trends of Stark parameters, we present our calculated Stark widths and Stark shifts versus temperature for some spectral lines of Mg III.

2 METHOD OF CALCULATION

As mentioned above, we use in this work the semi-empirical approach suggested by Griem (1968). In this way our calculation procedure is similar to those presented in recent publications by Alonso-Medina & Colón (2011, 2012, 2013).

The Stark line width and Stark line shifts can be calculated from the following semi-empirical formulae:

$$\omega_{se} \approx 8\left(\frac{\pi}{3}\right)^{3/2} \frac{\hbar}{ma_0} N_e \left(\frac{E_H}{kT}\right)^{1/2} \left[\sum_{i'} \left|\langle i'|\,\vec{r}\,|i\rangle\right|^2 g_{se} \times \left(\frac{E}{\Delta E_{i'i}}\right) + \sum_{f'} \left|\langle f'|\,\vec{r}\,|f\rangle\right|^2 g_{se}\left(\frac{E}{\Delta E_{f'f}}\right)\right] \tag{1}$$

$$d \approx -8\left(\frac{\pi}{3}\right)^{3/2} \frac{\hbar}{ma_0} N_e \left(\frac{E_H}{kT}\right)^{1/2} \left[\sum_{i'} \left(\frac{\Delta E_{i'i}}{|\Delta E_{i'i}|}\right) \left|\langle i'|\,\vec{r}\,|i\rangle\right|^2 \times g_{sh}\left(\frac{E}{\Delta E_{i'i}}\right) - \sum_{f'} \left(\frac{\Delta E_{f'f}}{|\Delta E_{f'f}|}\right) \left|\langle f'|\,\vec{r}\,|f\rangle\right|^2 g_{sh}\left(\frac{E}{\Delta E_{f'f}}\right)\right] \tag{2}$$

where ω_{se} and d represented the Stark line width and shifts respectively in angular frequency units, N_e is the perturber (free electron) density, T the electron temperature, $E = \frac{3}{2}kT$ the mean energy of the perturbing electron and E_H the hydrogen ionization energy. The indexes 'i' and 'f' denote the initial (upper) and final (lower) levels of the transitions, respectively. ω_{se} is the half-width at half maximum (HWHM) of the Lorentz profile in frequency units. ω_{se} is proportional to the full-width at half maximum (FWHM) line ω in wavelength units, through the expression $\omega = \omega_{se}\,\lambda^2/(\pi c)$.

These formulae are based on Baranger's original formulation (Baranger 1958) and the use of effective Gaunt factors g_{se} and g_{sh}, proposed by Seaton (1962) and Van Regemorter (1962). These factors are slowly varying functions of $x_{i'i} = E/\Delta E_{i'i}$, where $\Delta E_{i'i}$ is the energy difference between a perturbing level i' and the perturbed level i. In this work, we used the Gaunt factors suggested by Niemann et al. (2003), because these factors give us theoretical values closer to the experimental values.

The matrix elements required in these formulae are calculated using intermediate coupling (IC) by means of the computer programs of Cowan (1981). In order to calculate these elements, we used the experimental energy level presented by Martin & Zalubas (1980) and a basis set as suggested by Froese Fischer & Tachiev (2004). Our basis set consists of five configurations of even parity, namely $2s^22p^6$, $2s^22p^53p$, $2s^22p^54p$, $2s^22p^54f$ and $2s^22p^55f$, and 18 configurations of odd parity, namely $2s^22p^5ns$ ($n = 3$–6), $2s^22p^5nd$ ($n = 3$–9), $2s^22p^55g$ and $2s2p^6np$ ($n = 3$–8) for odd parity.

As the total number of parameters to adjust is excessive (i.e. exceeds of the number of experimental levels), we have chosen to exclude a certain number of parameters from the adjustment process. For all the F^k, G^k and R^k integrals not adjusted in the fitting procedure, we take the HFR *ab initio* values scaled down by a factor of 0.85 (as suggested by Cowan). For the spin-orbit integrals ζ_{nl}, characterized by small numerical values and not adjusted in the fitting procedures, we used the HFR *ab initio* values without scaling. Our results are not essentially different from those published by Anderson & Johannesson (1971) and therefore we do not present details here, but these can be obtained upon request from the authors.

3 RESULTS AND DISCUSSION

In Table 1 we present some of the results obtained in this work for transition probabilities and lifetimes. In this table we present only the values obtained for lines arising from energy levels for which there are experimental lifetimes. In this way we perform a comparison between the theoretical transition probabilities of Froese Fischer & Tachiev (2004), experimental lifetime values and our calculations. This comparison was performed to test the goodness of the matrix elements that we have used to calculate the broadening parameters. As can be seen, our values are in good agreement with the theoretical values with the exception of the two resonant lines, which deviate by the order of a factor of 1.6 but approach the experimental lifetimes more in these two cases. Also our results are agreement with the experimental lifetime values and fit recent experimental values that have been corrected for cascades Andersen et al. (1975).

Stark broadening parameters for 237 spectral lines of Mg III are presented in Tables 2, 3 and 4. Except for the six values presented by Popović and Dimitrijević, these values are reported in the literature for the first time. Data are presented at an electron density of $10^{17}\,\mathrm{cm}^{-3}$ and for several temperatures ($T = 5\,000$, $10\,000$, $20\,000$ and $50\,000$ K). For the astrophysically relevant lines at 330.00, 330.73, 23.42 and 23.17 nm, we have also added the temperatures in the tables ($T = 35\,000$, $60\,000$, $75\,000$ and $100\,000$ K).

In the first column in the broadening tables (Tables 2, 3 and 4), we present the corresponding wavelengths in nm (see Martin & Zalubas 1980). The second column indicates that the configuration of energy levels in the coupling scheme is more adequate in each case. In column 3 we displayed the temperatures. Stark

Table 1. Transition probabilities of several spectral lines arising from $2p^5\,3s$ and $2p^5np$ ($n = 3, 4$) configurations of Mg III and radiative lifetimes of levels of these configurations.

Transition levels		λ (nm)[a]	Transition probabilities ($10^7\ s^{-1}$)		Lifetimes (ns)	
Upper	Lower		This work	Other authors	This work	Other authors
$2p^53s\ ^3P_1$	$2p^6\ ^1S_0$	23.43	85.3	47.0[g]	1.17	3.8 ± 0.3[c]
						1.9 ± 20 per cent[e]
						1.9 ± 0.19[f]
$2p^53s\ ^1P_1$	$2p^6\ ^1S_0$	23.17	1315.4	916.0[g]	0.076	2.8 ± 0.3[c]
						0.1 ± 10 per cent[e]
						0.11 ± 15 per cent[f]
$2p^53p\ ^3S_1$	$2p^53s\ ^3P_2$	239.59	18.9	16.7[g]	3.44	3.4 ± 0.4[d]
						5.1 ± 0.15[b]
	$2p^53s\ ^3P_1$	246.85	7.85	6.91[g]		4.95 ± 0.10[b]
	$2p^53s\ ^3P_0$	252.99	2.17	1.89[g]		
	$2p^53s\ ^1P_1$	278.95	0.16	0.097[g]		
$2p^53p\ ^3D_3$	$2p^53s\ ^3P_2$	206.56	42.7	42.1[g]	2.34	2.4 ± 0.4[d]
						3.6 ± 0.15[b]
$2p^53p\ ^3D_2$	$2p^53s\ ^3P_2$	204.02	15.4	15.4[g]	2.35	2.3 ± 0.3[d]
						3.35 ± 0.15[b]
	$2p^53s\ ^3P_1$	209.26	26.9	25.7[g]		
	$2p^53s\ ^1P_1$	231.88	0.18	0.044[g]		
$2p^53p\ ^3D_1$	$2p^53s\ ^3P_2$	200.55	3.10	3.33[g]	2.34	3.30 ± 0.15[b]
						3.10 ± 0.15[b]
	$2p^53s\ ^3P_1$	205.61	23.3	23.5[g]		
	$2p^53s\ ^3P_0$	209.86	16.3	15.0[g]		
	$2p^53s\ ^1P_1$	227.41	0.0064	0.012[g]		
$2p^53p\ ^1D_2$	$2p^53s\ ^3P_2$	193.07	15.4	17.0[g]	2.24	2.2 ± 0.3[d]
						3.35 ± 0.10[b]
	$2p^53s\ ^3P_1$	197.75	5.30	4.94[g]		
	$2p^53s\ ^1P_1$	217.84	24.0	21.2[g]		
$2p^53p\ ^1P_1$	$2p^53s\ ^3P_2$	189.63	5.63	4.20[g]	2.15	2.0 ± 0.2[d]
						3.0 ± 0.1[b]
	$2p^53s\ ^3P_1$	194.15	5.38	3.27[g]		
	$2p^53s\ ^3P_0$	197.93	13.1	12.2[g]		
	$2p^53s\ ^1P_1$	213.47	22.4	23.6[g]		
$2p^53p\ ^3P_2$	$2p^53s\ ^3P_2$	187.95	20.9	17.6[g]	2.00	2.1 ± 0.2[d]
						3.0 ± 0.1[b]
	$2p^53s\ ^3P_1$	192.39	13.2	13.7[g]		
	$2p^53s\ ^1P_1$	211.34	16.7	16.9[g]		
$2p^53p\ ^3P_0$	$2p^53s\ ^3P_1$	190.85	53.2	51.5[g]	1.82	
	$2p^53s\ ^1P_1$	209.15	1.58	1.21[g]		
$2p^53p\ ^3P_1$	$2p^53s\ ^3P_2$	185.82	12.2	12.8[g]	1.97	3.0 ± 0.1[b]
	$2p^53s\ ^3P_1$	190.16	4.66	5.47[g]		
	$2p^53s\ ^3P_0$	193.78	13.6	14.6[g]		
	$2p^53s\ ^1P_1$	208.65	20.2	16.1[g]		
$2p^5(^2P_{3/2})4p\ ^2[5/2]_3$	$2p^53s\ ^3P_2$	73.44	7.25		3.49	7.6 ± 0.7[c]
	$2p^53d\ ^3P_2$	324.30	0.034			
	$2p^53d\ ^3F_4$	330.73	11.5			
	$2p^53d\ ^3F_3$	333.72	0.96			
	$2p^53d\ ^3F_2$	343.96	0.096			
	$2p^53d\ ^1F_3$	346.89	1.48			
	$2p^53d\ ^3D_3$	372.09	0.39			
	$2p^53d\ ^3D_2$	375.67	0.12			
	$2p^53d\ ^1D_2$	370.07	0.024			
	$2p^5(^2P_{3/2})4s\ ^2[3/2]_2$	625.85	6.88			
$2p^5(^2P_{3/2})4p\ ^2[5/2]_2$	$2p^53s\ ^3P_2$	73.26	2.50		3.43	6.6 ± 0.5[c]
	$2p^53s\ ^3P_1$	73.93	4.25			
	$2p^53s\ ^1P_1$	76.57	0. 74			
	$2p^53d\ ^3P_1$	315.30	0. 17			
	$2p^53d\ ^3P_2$	320.79	0. 36			
	$2p^53d\ ^3F_3$	330.00	10.9			
	$2p^53d\ ^3F_2$	340.02	2.56			
	$2p^53d\ ^1F_3$	342.88	0.0034			
	$2p^53d\ ^3D_1$	357.93	0.218			

Table 1 – *continued*

Transition levels		λ (nm)[a]	Transition probabilities (10^7 s^{-1})		Lifetimes (ns)	
Upper	Lower		This work	Other authors	This work	Other authors
	$2p^5 3d\ ^3D_3$	367.48	0.0518			
	$2p^5 3d\ ^3D_2$	370.97	0.189			
	$2p^5 3d\ ^1D_2$	365.51	0.324			
	$2p^5 3d\ ^1P_1$	384.85	0.0493			
	$2p^5(^2P_{3/2})4s\ ^2[3/2]_2$	612.91	2.90			
	$2p^5(^2P_{3/2})4s\ ^2[3/2]_1$	640.84	3.99			
$2p^5(^2P_{3/2})4p\ ^2[3/2]_2$	$2p^5 3s\ ^3P_2$	72.83	2.39		3.33	7.9 ± 0.8[c]
	$2p^5 3s\ ^3P_1$	73.49	1.00			
	$2p^5 3s\ ^1P_1$	76.10	2.35			
	$2p^5 3d\ ^3P_1$	307.51	1.01			
	$2p^5 3d\ ^3P_2$	312.73	4.02			
	$2p^5 3d\ ^3F_3$	321.48	0.402			
	$2p^5 3d\ ^3F_2$	330.97	0.0157			
	$2p^5 3d\ ^1F_3$	333.68	9.70			
	$2p^5 3d\ ^3D_1$	347.92	0.0260			
	$2p^5 3d\ ^3D_3$	356.94	0.493			
	$2p^5 3d\ ^3D_2$	360.23	0.837			
	$2p^5 3d\ ^1P_1$	373.31	0.0083			
	$2p^5(^2P_{3/2})4s\ ^2[3/2]_2$	584.14	4.53			
	$2p^5(^2P_{3/2})4s\ ^2[3/2]_1$	609.46	2.85			
	$2p^5(^2P_{3/2})4s\ ^2[1/2]_1$	703.29	0.422			

[a] Martin & Zalubas (1980).
[b] Andersen et al.(1970).
[c] Lundin et al. (1973).
[d] Andersen et al. (1975).
[e] Buchet et al. (1980).
[f] Träbert (1996).
[g] Froese Fischer & Tachiev (2004).

Table 2. Mg III $2p^6$–$2p^5ns$ (3–5) and $2p^5np$ (3, 4)–$2p^5ns$ (3–5) linewidths (FWHM) ω (pm) and shifts d (pm), normalized to $N_e = 10^{17}$ cm^{-3}. We present values only for 15 lines. The remaining lines (up to 64) are presented online.

N°	Wavelength λ (nm)[a]	Transition levels Configuration	Term	J–J	T (10^4 K)	ω (pm)	d (pm)
1	23.17	$2p^6$–$2p^5 3s$	^1S–^1P	0–1	0.5	0.105	−0.101
					1	0.065	−0.062
					2	0.040	−0.039
					3.5	0.028	−0.027
					5	0.022	−0.022
					6	0.020	−0.019
					7.5	0.018	−0.017
					10	0.015	−0.014
2	23.43	$2p^6$–$2p^5 3s$	^1S–^3P	0–1	0.5	0.103	−0.103
					1	0.063	−0.063
					2	0.040	−0.039
					3.5	0.028	−0.027
					5	0.022	−0.022
					6	0.020	−0.020
					7.5	0.017	−0.017
					10	0.015	−0.015
3	127.48	$2p^5 3p$–$2p^5(^2P_{3/2})4s$	^3S–$^2[3/2]$	1–2	0.5	21.2	−16.6
					1	13.4	−10.5
					2	8.66	−6.89
					5	5.11	−4.12
4	139.34	$2p^5 3p$–$2p^5(^2P_{3/2})4s$	^3D–$^2[3/2]$	3–2	0.5	31.5	−23.2
					1	19.8	−14.6
					2	12.7	−9.49
					5	7.41	−5.63

Table 2 – *continued*

N°	Wavelength λ (nm)[a]	Transition levels Configuration	Term	J–J	T (10^4 K)	ω (pm)	d (pm)
5	140.52	$2p^53p–2p^5(^2P_{3/2})4s$	$^3D–^2[3/2]$	2–2	0.5	29.0	−21.9
					1	18.2	−13.9
					2	11.7	−9.04
					5	6.89	−5.39
6	142.21	$2p^53p–2p^5(^2P_{3/2})4s$	$^3D–^2[3/2]$	1–2	0.5	26.5	−20.8
					1	16.7	−13.2
					2	10.8	−8.63
					5	6.39	−5.17
7	146.23	$2p^53p–2p^5(^2P_{3/2})4s$	$^1D–^2[3/2]$	2–2	0.5	31.5	−23.8
					1	19.8	−15.1
					2	12.8	−9.81
					5	7.49	−5.85
8	148.27	$2p^53p–2p^5(^2P_{3/2})4s$	$^1P–^2[3/2]$	1–2	0.5	28.9	−22.6
					1	18.2	−14.4
					2	11.8	−9.4
					5	6.96	−5.64
9	149.31	$2p^53p–2p^5(^2P_{3/2})4s$	$^3P–^2[3/2]$	2–2	0.5	32.8	−24.8
					1	20.6	−15.7
					2	13.3	−10.3
					5	7.81	−6.11
10	150.68	$2p^53p–2p^5(^2P_{3/2})4s$	$^3P–^2[3/2]$	1–2	0.5	29.9	−23.4
					1	18.8	−14.9
					2	12.2	−9.71
					5	7.19	−5.83
11	18.30	$2p^6–2p^5(^2P_{3/2})4s$	$^1S–^2[3/2]$	0–1	0.5	0.23	−0.19
					1	0.14	−0.12
					2	0.09	−0.08
					5	0.06	−0.05
12	126.34	$2p^53p–2p^5(^2P_{3/2})4s$	$^3S–^2[3/2]$	1–1	0.5	14.1	−10.4
					1	8.83	−6.58
					2	5.69	−4.28
					5	3.34	−2.55
13	139.13	$2p^53p–2p^5(^2P_{3/2})4s$	$^3D–^2[3/2]$	2–1	0.5	20.2	−14.4
					1	12.6	−9.07
					2	8.10	−5.87
					5	4.71	−3.47
14	140.79	$2p^53p–2p^5(^2P_{3/2})4s$	$^3D–^2[3/2]$	1–1	0.5	17.6	−13.1
					1	11.0	−8.28
					2	7.11	−5.39
					5	4.17	−3.21
15	144.73	$2p^53p–2p^5(^2P_{3/2})4s$	$^1D–^2[3/2]$	2–1	0.5	21.9	−15.6
					1	13.7	−9.83
					2	8.81	−6.37
					5	5.13	−3.77

Note. A positive shift is red.
[a] Martin & Zalubas (1980).

broadening linewidths (in pm) and Stark broadening line shift (in pm) are shown in the two last columns. As is well known, both positive and negative contributions of perturber level can be present in Stark line-shift calculations (Griem 1968). Sometimes near-cancellation occurs, resulting in very small shifts for lines that have large widths. In these cases the experimental shift values can be smaller than the uncertainty in any semi-classical calculation. Since displacements are very sensitive to the set of transition probabilities used, we should be able to find discrepancies between our results for the displacements and experimental values measured in future.

One of the most relevant characteristics of the data is that in general the broadenings are particularly low, of the order of picometres, except for a few lines from the configurations $2p^55s$, $2p^54p$ and $2p^54d$. In at least two cases these lines, such as 330.73 and 330.00 nm of special interest (as mentioned above), have broadenings of the order of angstroms. As the description of the levels of these configurations should not be performed in the exact model of *LS* coupling, it is possible that any other method based exclusively on the Coulomb approximation will provide less accurate data. Many of the transitions involved in these calculations would be *LS*-unallowed. Using a pure *LS* model has led to underestimation of the values of the parameters.

In Fig. 1, we display the theoretical trends of our calculated Stark widths and Stark shifts versus temperature for the 330.00, 330.73, 23.42 and 23.17 nm spectral lines of astrophysical interest for Mg III.

Table 3. Mg III $2p^5ns$ (3, 4)–$2p^5np$ (3, 4) and $2p^53d$–$2p^54p$ linewidths (FWHM) ω (pm) and shifts d (pm), normalized to $N_e = 10^{17}$ cm^{-3}. We present values only for 15 lines. The remaining lines (up to 92) are presented online.

N°	Wavelength λ (nm)[a]	Transition levels Configuration	Term	J-J	T (10^4 K)	ω (pm)	d (pm)
1	239.59	$2p^53s$–$2p^53p$	^3P–^3S	2–1	0.5	28.99	−22.53
					1	17.82	−13.83
					2	11.14	−8.63
					5	6.22	−4.79
2	246.85	$2p^53s$–$2p^53p$	^3P–^3S	1–1	0.5	24.05	−17.16
					1	14.78	−10.52
					2	9.23	−6.55
					5	5.14	−3.62
3	253.00	$2p^53s$–$2p^53p$	^3P–^3S	0–1	0.5	18.13	−10.92
					1	11.13	−6.68
					2	6.94	−4.14
					5	3.86	−2.27
4	278.95	$2p^53s$–$2p^53p$	^1P–^3S	1–1	0.5	31.34	−22.00
					1	19.26	−13.49
					2	12.02	−8.40
					5	6.69	−4.65
5	206.56	$2p^53s$–$2p^53p$	^3P–^3D	2–3	0.5	35.04	−24.15
					1	21.53	−14.82
					2	13.45	−9.24
					5	7.49	−5.13
6	204.02	$2p^53s$–$2p^53p$	^3P–^3D	2–2	0.5	27.74	−20.14
					1	17.05	−12.37
					2	10.65	−7.72
					5	5.94	−4.29
7	209.26	$2p^53s$–$2p^53p$	^3P–^3D	1–2	0.5	24.35	−16.33
					1	14.96	−10.02
					2	9.34	−6.24
					5	5.20	−3.46
8	231.88	$2p^53s$–$2p^53p$	^1P–^3D	1–2	0.5	30.33	−20.11
					1	18.63	−12.34
					2	11.63	−7.69
					5	6.48	−4.27
9	200.55	$2p^53s$–$2p^53p$	^3P–^3D	2–1	0.5	20.54	−16.14
					1	12.63	−9.92
					2	7.90	−6.20
					5	4.41	−3.46
10	205.61	$2p^53s$–$2p^53p$	^3P–^3D	1–1	0.5	16.93	−12.28
					1	10.40	−7.54
					2	6.50	−4.71
					5	3.63	−2.62
11	209.86	$2p^53s$–$2p^53p$	^3P–^3D	0–1	0.5	12.72	−7.90
					1	7.81	−4.84
					2	4.88	−3.01
					5	2.71	−1.67
12	227.41	$2p^53s$–$2p^53p$	^1P–^3D	1–1	0.5	21.12	−15.08
					1	12.98	−9.26
					2	8.11	−5.78
					5	4.52	−3.22
13	193.07	$2p^53s$–$2p^53p$	^3P–^1D	2–2	0.5	25.04	−18.09
					1	15.39	−11.12
					2	9.62	−6.94
					5	5.37	−3.87
14	197.76	$2p^53s$–$2p^53p$	^3P–^1D	1–2	0.5	21.95	−14.65
					1	13.49	−8.99
					2	8.43	−5.61
					5	4.70	−3.12
15	217.84	$2p^53s$–$2p^53p$	^1P–^1D	1–2	0.5	27.02	−17.82
					1	16.61	−10.94
					2	10.37	−6.83
					5	5.78	−3.80

Note. A positive shift is red.
[a] Martin & Zalubas (1980).

Table 4. Mg III $2p^6$–$2p^5nd$ (3, 4) and $2p^5np$ (3, 4)–$2p^5nd$ (3, 4) linewidths (FWHM) ω (pm) and shifts d (pm), normalized to $N_e = 10^{17}$ cm^{-3}. We present values only for 15 lines. The remaining lines (up to 81) are presented online.

N°	Wavelength λ (nm)[a]	Transition levels Configuration	Term	J–J	T (10^4 K)	ω (pm)	d (pm)
1	159.24	$2p^53p$–$2p^53d$	^3S–^3P	1–0	0.5	8.37	−4.03
					1	5.14	−2.46
					2	3.21	−1.52
					5	1.78	−0.84
2	182.90	$2p^53p$–$2p^53d$	^3D–^3P	1–0	0.5	11.24	−5.61
					1	6.90	−3.44
					2	4.31	−2.14
					5	2.40	−1.18
3	193.04	$2p^53p$–$2p^53d$	^1P–^3P	1–0	0.5	12.65	−6.33
					1	7.77	−3.89
					2	4.85	−2.42
					5	2.70	−1.35
4	197.15	$2p^53p$–$2p^53d$	^3P–^3P	1–0	0.5	13.20	−6.62
					1	8.11	−4.06
					2	5.07	−2.53
					5	2.82	−1.41
5	18.85	$2p^6$–$2p^53d$	^1S–^3P	0–1	0.5	0.12	−0.05
					1	0.07	−0.03
					2	0.04	−0.02
					5	0.03	−0.01
6	158.62	$2p^53p$–$2p^53d$	^3S–^3P	1–1	0.5	13.49	−6.20
					1	8.29	−3.80
					2	5.18	−2.37
					5	2.88	−1.31
7	179.32	$2p^53p$–$2p^53d$	^3D–^3P	2–1	0.5	22.43	−10.86
					1	13.78	−6.67
					2	8.61	−4.16
					5	4.79	−2.31
8	188.73	$2p^53p$–$2p^53d$	^1D–^3P	2–1	0.5	25.03	−12.09
					1	15.38	−7.42
					2	9.61	−4.63
					5	5.36	−2.58
9	192.14	$2p^53p$–$2p^53d$	^1P–^3P	1–1	0.5	20.13	−9.51
					1	12.37	−5.85
					2	7.73	−3.66
					5	4.31	−2.04
10	193.89	$2p^53p$–$2p^53d$	^3P–^3P	2–1	0.5	26.43	−12.84
					1	16.24	−7.89
					2	10.15	−4.93
					5	5.66	−2.74
11	195.48	$2p^53p$–$2p^53d$	^3P–^3P	0–1	0.5	14.81	−6.64
					1	9.11	−4.09
					2	5.70	−2.56
					5	3.18	−1.44
12	196.21	$2p^53p$–$2p^53d$	^3P–^3P	1–1	0.5	21.00	−9.93
					1	12.91	−6.11
					2	8.07	−3.82
					5	4.50	−2.13
13	157.27	$2p^53p$–$2p^53d$	^3S–^3P	1–2	0.5	18.41	−8.32
					1	11.32	−5.11
					2	7.07	−3.19
					5	3.94	−1.77
14	186.82	$2p^53p$–$2p^53d$	^1D–^3P	2–2	0.5	31.79	−14.98
					1	19.54	−9.21
					2	12.22	−5.75
					5	6.82	−3.21
15	190.16	$2p^53p$–$2p^53d$	^1P–^3P	1–2	0.5	27.24	−12.56
					1	16.75	−7.73
					2	10.47	−4.84
					5	5.85	−2.71

Note. A positive shift is red.
[a] Martin & Zalubas (1980).

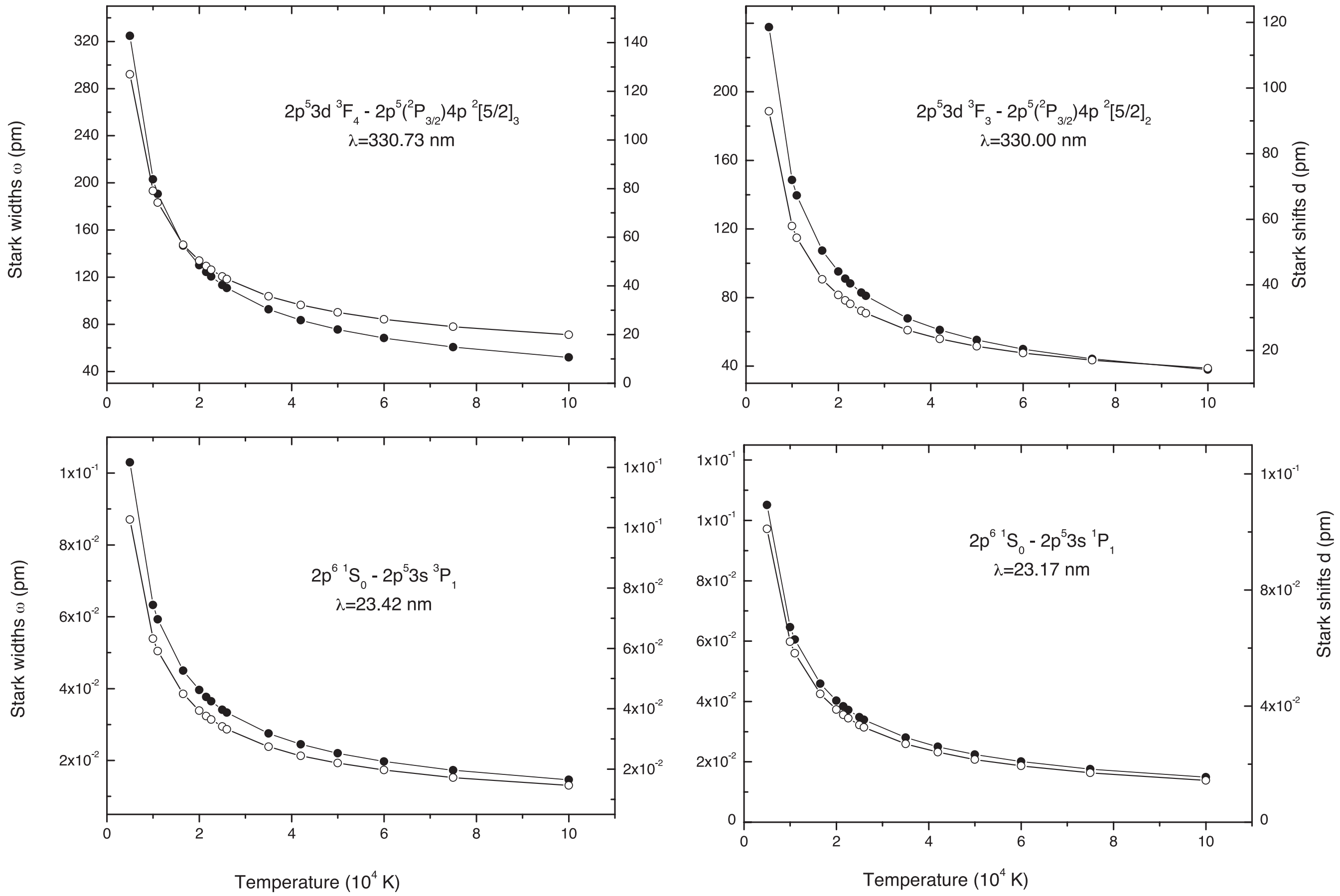

Figure 1. Calculated Stark width FWHM (ω (pm)) and shift (d (pm)) versus temperature for 330.73, 330.00, 23.42 and 23.71 nm Mg III lines at an electron density of 10^{17} cm^{-3}.

In conclusion, we have obtained the Stark broadening parameters of 237 Mg III spectral lines. Except for six values found in the literature, these values are reported in the literature for the first time. These data are of high interest for the modelling of astrophysical atmospheres. Clear trends in Stark width are seen in our results.

ACKNOWLEDGEMENTS

This work has been supported by the Spanish DGI project MAT2012–37782.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Table 2. Mg III $2p^6$–$2p^5ns$ (3–5) and $2p^5np$ (3, 4)–$2p^5ns$ (3–5) linewidths (FWHM) ω (pm) and shifts d (pm), normalized to $N_e = 10^{17}\,\mathrm{cm}^{-3}$.
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